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Electronics for Scientists

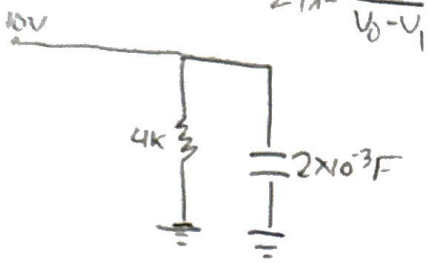
RC Circuit

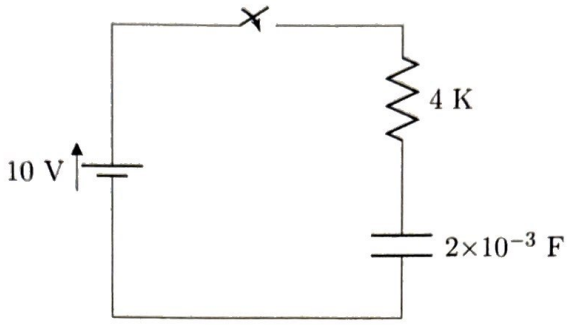
Instructions

Complete the following exercises to the best of your ability.

A RC circuit has a 10 volt battery, a switch, a 4 K resistor and a 2×10^{-3} F capacitor, as shown below.

$Z_{in} = \frac{-V_1 R}{V_0 - V_1}$





$V_1 = V_0 e^{-t/\tau}$

$I = \frac{\Delta V}{R}$ $\Delta V = 12V$

$\Delta V =$

$I = C\frac{dv}{dt}$

The capacitor is initially uncharged and the switch is closed at $t = 0$.

1. What is the time constant for this circuit?
2. At a time of 1 time constant after the switch is closed, find the current through the circuit, the voltage across and resistor, and the voltage across the capacitor.
3. At a time of 2 time constant after the switch is closed, find the current through the circuit, the voltage across and resistor, and the voltage across the capacitor.

1.) $\tau = RxC$

$= 4K(2\times10^{-3}F) = 8$

$\tau = 8$ s

$t = 1RC$

2) $t = 1.8$ $\tau = 8$ $V_1 = 10ve^{-1.8/8} = 8.8V$ $\Delta V = 1.2V$ $Z_1 = 33,333.3\,\Omega$

$I = 0.26\,mA$

$V_R = 1.07V$ $V_C = 0.134V$

3.) $t = 2$ $\tau = 16$ $V_1 = 10Ve^{-1/8} = 8.8V$

$I = 0.26mA$

$V_R = 1.07V$ $V_C = 0.134V$

Taylor Larrechea
Dr. Heeterman
Phys 251 HW 3

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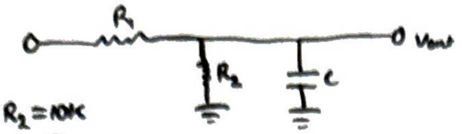

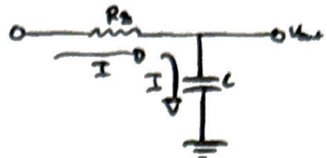

$I = C\frac{dv}{dt}$ $I = \frac{\Delta V}{R}$

$\frac{dv}{dt} = \frac{\Delta V}{\Delta t}$

$R_1 = R_2 = 10K$

$C = 0.1\,\mu F$

$R_3 = R_1 + R_2$

$R_3 = \frac{R_1 R_2}{R_1 + R_2} = \frac{10k(10k)}{10k + 10k} = 5K$ ✓

current ≠ voltage?

$I(5K) + I(0.1\mu F) = V_f$

$I(R) + I(C) = V_f$???

$RC\frac{dv}{dt} + \frac{dv}{dt}\frac{t}{R} = V_f$

$\frac{dv}{dt}\left(RC + \frac{t}{R}\right) = V_f$

$\frac{dv}{dt}\left(\frac{R+1}{Rt}\right) = V_f$

$\frac{dv}{dt} = V_f\left(\frac{Rt}{R+1}\right)$

$\int \frac{dv}{V_f} = \frac{10}{11}\int t\,dt$

$\ln V = \frac{10}{22}t^2 + K$

$RC + \frac{t}{R}$

$R(RC) + RC$

$\frac{t(R+1)}{R}$

$V = e^{\frac{10}{22}t^2}$

$V = e^{-\frac{5}{11}t^2}$

1.18)

$C = 1\,\mu F$

$I = 1\,mA$

$V = 10\,V$

$Q = CV$

$Q = I \cdot \Delta t$

$CV = I\Delta t$

$\Delta t = \frac{CV}{I} = \frac{1.0\times10^{-6}F\,(10V)}{1.0\times10^{-3}A} = 0.01S$

$\Delta t = 0.01S$ ✓